processors, digital signal processors (DSPs) and processors based on a multicore processor architecture, as non-limiting examples.

[0078] Certain exemplary embodiments of the invention offer the following technical effects. First, a speaker with a larger radiating area can be made in a host device but without increasing the total volume of space inside the host device that is taken up by the speaker. This leads to increased sound quality and efficiency. Currently in many consumer products the drive is to increase the display area and to minimize cover space sound oulets (or "exit wounds" in industrial designer parlance), which results in compromized audio performance. This advantage is particualry usefule to improve performance for mobile terminal audio conferencing.

[0079] Second, the increased radiating area enables sound to be narturally beamed to the user from the direction that same user perceives the video (for the case in which the audio is related to the video as with video-conferencing), with no special processing. While not particularly shown, the invention may be embodied as a plurality or array of loudspeakers, each similar in structure those individual speakers detailed above but all in combination with a single graphical display panel, or for example in which the array is defined as a single electret/electrostatic speaker with partitioned electrodes. Such an arrayed speaker embodiment can be controlled by computer program software stored on a local memory to manipulate the directional sound behavior in order to make the sound beam pattern narrower or wider, depending automatically upon the application or upon manual user selection. Directional control is particularly advantageous for realistic three-dimensional (or "wide") stereo.

[0080] Third, for the case of a dipole implementation certain exemplary embodiments enable improve privacy of audio at low frequencies by virtue of the fact that no sound is transmitted laterally. The dipole embodiemtns are seen to be most easily implemented in flip-type mobile stations as opposed to monoblocks due to the need for a rear sound outlet and symmetrical acoustic paths on opposed sides of the diaphragm. But such a flip-style dipole implementation can be used quite easily in other classes of consumer products such as laptop personal computers, and also in non-flip style products like desktop flat panel computer displays and televisions where the sound can be ported out freely from both the front and back of the display. Additional advantages may be seen where a personalised audio volume is desireable, such as for example at video displays at individual airline seats so closely spaced passengers can each hear the different programs they're viewing without the need for headsets/earphones. Similar advantage can be used in an automobile application in which there are multiple monitors for passengers.

[0081] Fourth, embodiments using an electret type speaker offer the technical advantage of high efficiency, low distortion, flat frequency resonse and the ability to form an array from a single speaker by simply partioning the electrodes into an array as noted above. The absence of a massive magnet driving the diaphragm as in a traditional loudspeaker saves space and eliminates other issues such as disturbing RF circuitry or erasing the magnetic stripe on credit cards. But while electret speakers typically require a relatively high drive voltage, they also operate on extremely small (less than 40 picofarad mainly capacitive load) current and power, facilitating small-space implementation such as handheld products such as mobile phones. Very compact DC voltage converters are commercially available.

[0082] Another technical advantage of the combined loudspeaker and display module/panel as detailed in the examples above is that such a module or sub-assembly is much simpler to integrate into an extremely thin end-product. For example, there is some research into mobile phones having the thickness apprioximately of a credit card. Integrating a prior art magnet-driven loudspeaker into such a thin device is impossible, and is quite difficult for other types of loudspeakers considering the related drive electronics and acoustical cavity necessary to make it operational.

[0083] Various modifications and adaptations to the foregoing exemplary embodiments of this invention may become apparent to those skilled in the relevant arts in view of the foregoing description, when read in conjunction with the accompanying drawings. However, any and all modifications will still fall within the scope of the non-limiting and exemplary embodiments of this invention.

[0084] Furthermore, some of the features of the various non-limiting and exemplary embodiments of this invention may be used to advantage without the corresponding use of other features. As such, the foregoing description should be considered as merely illustrative of the principles, teachings and exemplary embodiments of this invention, and not in limitation thereof.

1-20. (canceled)

21. An apparatus, comprising:

a graphical display panel comprising a display layer for displaying images and defining a plurality of sound apertures penetrating through at least the display layer, wherein the display layer comprises a plurality of pixels for displaying the images, and wherein the plurality of sound apertures are disposed among the plurality of pixels; and

a loudspeaker comprising a diaphragm configured to generate sound, wherein the loudspeaker is configured such that sound emanates at least from the plurality of sound apertures.

22. The apparatus according to claim **21**, wherein a radius of each of the plurality of apertures is based, at least in part, on an acoustic resistance.

23. The apparatus according to claim **21**, wherein a length of each of the plurality of apertures is based, at least in part, on an acoustic resistance.

24. The apparatus according to claim **21**, wherein a size of each of the plurality of apertures is configured to provide optimum acoustic resistance for controlling the vibration modes of a membrane achieve a flat frequency response.

25. The apparatus according to claim **21**, wherein the loudspeaker comprises a first electrode and a second electrode;

wherein the diaphragm is disposed between the first electrode and the second electrode, and the first electrode is disposed as a layer of the graphical display panel.

26. The apparatus according to claim **25**, wherein the loudspeaker is a push pull electret speaker and the diaphragm comprises a conductive film with a charge storing membrane.

27. The apparatus according to claim **26**, wherein the plurality of apertures penetrate through the first electrode, and the second electrode defines a second plurality of apertures that penetrate the second electrode, wherein the second electrode is disposed adjacent to a housing in which the apparatus is disposed, and the second plurality of apertures penetrates through the housing such that the electret speaker is enabled to directionally emit sound via a dipole pattern that is symmetric about the diaphragm.